



DRINKING WATER SOURCE PROTECTION

ACT FOR CLEAN WATER

Technical Bulletin: Water Budget and Water Quantity Risk Assessment - Tier 2 Subwatershed Stress Assessment - Groundwater Drought Scenarios

Date: July 2009

Ontario Ministry of Natural Resources

Ontario Ministry of the Environment

The Clean Water Act requires Source Protection Committees (SPCs) to prepare an assessment report for each source protection area it represents, in accordance with the regulations, the Director's Technical Rules and the approved terms of reference for that source protection area.

As part of the assessment report, SPCs must identify four types of vulnerable areas within each source protection area. These include wellhead protection areas (WHPAs), intake protection zones (IPZs), highly vulnerable aquifers (HVAs), and significant groundwater recharge areas (SGRAs) for types I, II and III drinking water systems. The SPCs must also assess risks to water quality and quantity for these drinking water systems. The water quality and quantity risk assessments complete the assessment report.

In order to evaluate the risks to water quantity, the SPC must evaluate the ability of the water supply to meet the community's drinking water needs following a tiered water budget analysis. This is called a stress assessment. This tiered approach uses water budget models in which the local water supply, water

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demands and the needs of the aquatic ecosystem will be compared through a process of successively more detailed and focused level of technical complexity, more refined information derived from water budgeting work and refined geographical scale. The water quantity risk assessment will also evaluate the potential hydrologic stress that could arise from future water needs and periods of drought.

The water budget and quantity risk assessment framework requires that drought scenarios be considered beginning at Tier 2.

This technical bulletin provides clarification to SPCs on the process of evaluating drought scenarios in the groundwater component of water budgets that are being developed for the water quantity risk assessment in order to assign Tier 2 subwatershed stress levels.

Definitions

“ten year drought period” means the continuous ten year period for which precipitation records exist with the lowest mean annual precipitation.

“two year drought period” means:

- (a) in relation to an assessment of surface water quantity, the continuous two year period for which precipitation records exist with the lowest mean annual precipitation, and
- (b) in relation to an assessment of groundwater quantity, a simulated two year period with no groundwater recharge.

Explanation of the Rules:

Technical Rule 35(2)(e) and Rule 35(2)(f)

- Rule 35(2)(f) specifies that a stress level can only be assigned as moderate if either of the circumstances listed in rule 35(2)(e) are triggered for both the two year and ten year drought scenarios. The two year drought analysis includes scenarios D (existing system – two year drought) and E (existing system – future two year drought). The ten year drought analysis includes scenarios G (existing system – ten year drought) and H (existing system – future ten year drought).

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- The above implies that if the simulations of both scenarios D and G or both scenarios E and H results in either of the following circumstances in Rule 35(2)(e) described below, then the stress level of the subwatershed should be assigned as moderate:

Circumstance 1: the groundwater in the vicinity of the well was not at level sufficient for the normal operation of the well or

Circumstance 2: the operation of a well pump was terminated because of an insufficient quantity of water being supplied to the well.

Technical Rule 35(3)

- Rule 35(3) specifies that if neither of the drought scenarios results in either of the above circumstances at the well, then the subwatershed stress level should be assigned as low.

Clarification of the Rules:

- The two year drought, unlike the ten year drought, has two separate methods; one for assessing surface water and one for assessing groundwater. The two year drought assessment for surface water is based on historical climate records; however the drought assessment for groundwater must be completed using zero recharge for a two year period, as per the definition.
- The intent of the rules are to provide, at first, a simple, conservative (e.g. zero recharge), two year drought scenario as a screening tool for groundwater that would not require a more thorough assessment of historical climate records and would include the use of the calibrated model in transient conditions, thereby saving time and effort.
- It is recognized that using zero recharge for the two year groundwater drought scenario provides a screening assessment that looks at the extreme “worst case” scenario that may produce greater levels of drawdown than the assessment of the ten year drought scenario.

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- Following the Rule 35(2)(f), the two year drought scenarios should be undertaken first. If neither of the two year drought scenarios D and E triggered a circumstance in 35(2)(e) then there is no requirement to undertake a further assessment of a ten year drought scenario. As stated in Rule 35(3), the subwatershed stress level should then be assigned as low.
- If either or both of the two year drought scenario(s) did trigger a circumstance in 35(2)(e) then a further assessment is required using a more representative ten year drought scenario that requires the assessment of climate data, estimation of monthly recharge rates, and the use of actual pumping rates in a transient groundwater model, which are the scenarios G and H.
- Professional judgement is needed to assess the drought scenarios when the historical climate period of record is relatively short (e.g. less than 20 years) and does not encompass a typical drought period (e.g. 1960's or late 1990's). In this situation using the two year drought scenario for groundwater (as opposed to the ten year drought scenario) may be more appropriate as a conservative estimate of drought conditions. In these circumstances, the team should select the most representative nearby climate station outside of the watershed with a longer term climate record.
- Historical observations of drought impacts to surface water and groundwater in the watershed are very important to verify the results of the drought scenarios. As an example, operator records of water levels, where available, can help to verify simulated water level fluctuations.

Questions

Question 1. Does the two year groundwater drought scenario need to be simulated if the ten year groundwater drought scenario is already complete?

Question 2. Can the two year and ten year groundwater drought scenarios be simultaneously evaluated using a transient model?

Question 3. Can the two year groundwater drought scenario use a continuous two year period for which records exist with the lowest mean annual precipitation rather than using zero recharge?

Question 4. Can the two year or ten year groundwater drought scenarios be evaluated using a steady state model?

Answers to Questions:

Question 1: Does the two year groundwater drought scenario need to be simulated if the ten year groundwater drought scenario is already complete?

If the ten year drought scenario has been completed and neither of the scenarios G and H triggered a circumstance in Rule 35(2)(e), then the stress level is assigned as low according to Rule 35(3) and therefore the two year drought scenario does not need to be run. If either of the ten year drought scenarios does trigger a circumstance in 35(2)(e) then you must still show that the two year drought scenario also triggers a circumstance in 35(2)(e) before you can assign the stress level as moderate.

Given the level of effort for the ten year versus two year drought scenarios, we recommend that the two year be run first, and if neither of the two year scenarios trigger a circumstance in 35(2)(e), then you are not required to do the more complex modelling required for the ten year drought scenario.

Question 2: Can the two year and ten year groundwater drought scenarios be simultaneously evaluated using a transient model?

In cases where the groundwater flow model has already been used to simulate a long-term transient period (i.e., 40 years), the results of those simulations can be

considered to be indicative of droughts of any time period (e.g., two year, ten year).

Simulating the two year and ten year drought scenarios simultaneously in transient mode and extracting the maximum groundwater drawdown estimates from the entire period of record (typically 30+ years) meets the intent of rule 35(2)(f) and 35(2)(g).

- From recent review of Tier 2 Water Budget reports it has become apparent that in the process of developing the requisite complex groundwater and surface water models it may be a straightforward process, in some cases, to run the groundwater model in full transient mode.
- Full transient mode simulation means that the entire historical climate period of record and variable pumping rates can be incorporated into a transient groundwater model capable of simulating varying groundwater levels.
- Full transient mode simulation allows for a more realistic (e.g. actual assessment of historical data) assessment of drought rather than using the conservative zero recharge for the two year drought scenario.
- The model developed in this manner enables water levels to be simulated at any location, during any time period or interval, throughout the entire period of record.

Question 3: Can the two year groundwater drought scenario use a continuous two year period for which climate records exist with the lowest mean annual precipitation rather than using zero recharge?

The two year groundwater drought scenario can not use a continuous two year period for which climate records exist with the lowest mean annual precipitation rather than using zero recharge. The two-year scenario with zero recharge is intended to be a screening scenario. A transient simulation using just two years of reduced recharge based on historical records may not appropriately simulate the longer term impacts of an actual drought.

Question 4: Can the two year or ten year groundwater drought scenarios be evaluated using a steady state model?

The drought scenarios must be simulated using a transient model. The transient model will account for changes in storage under varying recharge and pumping rates.

Notable Points:

- There is inherent uncertainty in the simulated drought water levels using regional groundwater models. However, as long as the water level drawdown in comparison to the available drawdown at the wells is acceptable, then there is confidence that the drought scenario will not impact the aquifer and the well will be able to continue to pump the allocated rate.
- The results of the simulation of the drought scenario and the assignment of subwatershed stress levels should be reviewed with the peer review team for the respective source protection area.